**Developing Seasonal Predictive Capability for a
Drought Mitigation Decision Support System**

Sub-project: Preliminary Report on an Internet Survey of Corn Growers Perceptions
About the Use and Value of Seasonal Forecasts

October 31, 2009

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The National Drought Mitigation Center (NDMC) is collaborating on a project to develop seasonal forecasts of climate, streamflow, and other drought-related indices to meet the needs of stakeholders in the Midwest. The project intends to facilitate a "risk management" to drought management that emphasizes mitigation and preparedness, as opposed to a reactive "crisis management" approach. To meet the intended objectives, it was vital to conduct a survey among its intended end-users to determine their general attitudes and needs related to the use of seasonal forecasts. The survey is helping to answer questions on the potential applicability of seasonal climatic, streamflow, and soil moisture forecasts among irrigated and dryland corn growers across the conterminous USA. This group was selected because they represent the largest segment of U.S. crop production and are significant water users.

Survey Methodology
After conducting a review of several potential software packages, NDMC staff designed an internet-based survey using Qualtrics software (http://www.qualtrics.com/ssp.html). Survey questions were selected and designed based on the goals/objectives of the survey, utilizing a combination of quantitative and qualitative questions. A variety of question formats (e.g., single answer, multiple answer, ranking order, and open-ended) were employed in the survey. Draft questionnaire versions were compiled and prepared, and discussed and modified for clarity continually over a three-month period. The questionnaire focused on respondent demographics, farm and irrigation management characteristics, sources of forecasts, and perceptions on the use of long-range forecasts (up to 90-days). The strategy of using open-ended questions served significantly in obtaining perceptions about the usefulness and accuracy of seasonal forecasts.

After a final version was developed by the research team, it was reviewed by members of NDMC who are not directly linked with the project. The survey was also sent reviewed by a local corn grower in Lancaster County, Nebraska and the State Climatologist of Missouri. All of their comments were implemented in the final revision. The survey protocol and instrument was also approved by the University of Nebraska-Lincoln Institutional Review Board (IRB# 9963), who is responsible for ensuring the rights of human research subjects. Project team members were also required to take IRB certification training.

With assistance from the National Corn Growers' Association (NCGA), it was determined that the survey would be directed towards NCGA action team members and corn board members, who are very active producers and represent corn growers throughout the United States. The action teams are organized to provide grassroots input into future corn production issues and are broken into production, stewardship, ethanol, climate change, policy, trade, research, and

business development teams. These participants were expected to serve as key informants for identifying a broad range of user perceptions on the use and value of climate forecasts.

In late July, a survey email invitation (including a link to the online survey) was sent to the NCGA, who forwarded it sixty action team and corn board members. A series of three reminders were sent every two weeks to remind and encourage respondents to complete the survey. 32 out of 60 respondents completed at least half of the survey for an initial response rate of 53%. In should be noted that one respondent opted out of the mid-way through the survey (response rate then is noted to be 52%). At this time, the data for this respondent **has not** been excluded from the report sections where the data applies. However, it may have to be deleted in the future for possible journal publications, especially when there is a need to make correlations within the data.
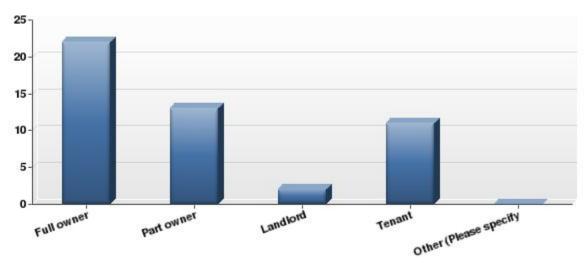
Results and Discussion

Demographics

The demographics section of the survey consisted of seven basic questions. 32 respondents replied to the questions that consisted of gaining information in regards to age, location, education, and farm operation structure.

Corn producers from fourteen states responded to the survey (i.e., AL, CO, IL, IN, IA, KS, MD, MN, MN, NE, ND, OH, SD, and TX). The age of respondents ranges between 35-74 years old, with 72% between 45-59 years old. In terms of education, 84% percent of respondents have some post-high school education, with 38% having a Bachelor's degree and 6% with a graduate degree.

All but one of the respondents manages the day-to-day operations of their farm. Out of the 32 respondents, 69% (22) are full owners, 41% (13) are part owner, and 34% (11) are tenants while 6% (2) are landlords *(Graph 1)*

Graph 1: Which best describes your farm operating structure in 2009? Please select all that apply.

Sources of Forecasts

Most of the respondents 94% (30 out of 32) utilizes the internet as an important media for weather forecast information. The radio and TV featured as two important media for weather information for 75% (24 out of 32 respondents) and 78% (25 out of 32 respondents) of the respondents respectively.

When asked to rank their sources of weather information for reliability (most trusted to least trusted), most respondents demonstrated a fairly large reliance on the television weatherperson (13 out of 31) and government weather people (10 out of 31) for weather forecasts. Neighbors and spouse/partner were least trusted for weather forecasts. ***Please note that this was a multiple answer question.***

Irrigation

A question was asked in reference to irrigation. If the respondents indicated that they did not irrigate, they were forwarded to the next portion of the survey. If they responded that did irrigate, they were asked to answer three more descriptive questions regarding their irrigation sources and practices.

Most of the respondents, who answered the question, indicated that they **do not** irrigate. Out of the 32 respondents who answered the question, nine indicated that they utilize irrigation in their corn crops. More descriptively, eight farmers irrigate by making use of their well water while two indicated that they utilize their on-farm surface water. Eight farmers irrigate corn for grain or seed with four farmers irrigating on less than 500 acres of land and the other four irrigating acres greater than 500. One farmer irrigates corn for greenchop or silage production on 100-139 acres of land. Irrigation normally takes place during the months of April to September but July and August both feature as important irrigation months for all the nine irrigators.

Value of weather forecast information in farm decision making

(Note: Response rate dropped to 31/60, or 52% at this point within the survey)

Respondents were asked the importance of weather forecasts in decision making. It is important to note that the respondents were able to choose multiple answers for the below two questions. It was also recorded that the total number of respondents still indicated 31 for this section of the survey.

From the survey results, soil moisture, rainfall and temperature were ranked within the high to very high importance category of observations that are necessary in farm decision making *(Table 1).* Snowfall and groundwater levels were also indicated as being important. Weather forecast information directed towards stream flow was indicated to be the least important to farmers.

Table 1: How important is each observation in your farm decision making?
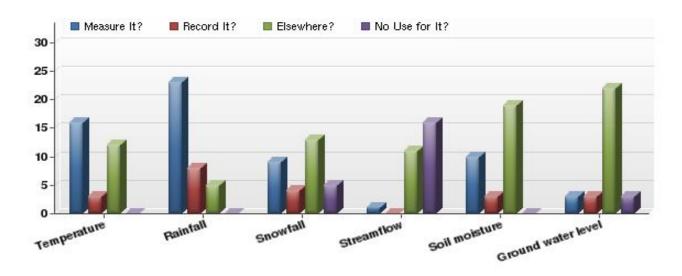
#	Question	Low importance	Moderate importance	Important	High importance	Very high importance	Responses	Mean
1	Temperature	0	3	8	15	5	31	3.71
2	Rainfall	0	0	6	9	15	30	4.30
3	Snowfall	7	6	14	2	2	31	2.55
4	Streamflow	18	6	4	2	1	31	1.77
5	Soil moisture	0	0	4	13	14	31	4.32
6	Groundwater level	3	1	16	8	3	31	3.23

The respondents were also asked how they "utilized" the possible important observations. These actions included measurement, recording (writing it down), finding it elsewhere such as from the Internet, or indicating that they had no use for the observation. *Table 2* indicates the actual data responses. *Graph 2* demonstrates that overall rainfall and temperature are the most measured observations. Also, in this graph, it is indicated that rainfall, snowfall, and temperature are the most recorded observations while groundwater levels and soil moisture is found elsewhere when needed. One respondent commented on this portion of the survey, which can be found below *Graph 1*.

Table 2: For each of the observations, do you measure, record it, or find it elsewhere?

#	Question	Measure It?	Record It?	Elsewhere?	No Use for It?	Responses
1	Temperature	16	3	12	0	31
2	Rainfall	23	8	5	0	36
3	Snowfall	9	4	13	5	31
4	Streamflow	1	0	11	16	28
5	Soil moisture	10	3	19	0	32
6	Ground water level	3	3	22	3	31

Graph 1: For each of the observations, do you measure, record it, or find it elsewhere?

Comment: "In our four county area, there is a large amount of electronic rain gauges spread out among area producers that can be accessed on a website and a producer can see the rainfall patterns. Our agronomist monitors soil moisture in each field weekly. Ground water levels are monitored by the local water conservation districts which we have access to the data."

Mid-range weather forecasts

Respondents were asked about the applicability of short and mid-range weather forecast information in their farming operations. Results show that several operations rely on short range forecasts *(Table 3)*. Approximately one third (1/3) of respondents schedule pesticide applications, crop inspections and planting based on two forecasts *(Table 3)*. Seven-day forecasts are mainly useful for scheduling pesticide applications, nutrient applications, crop inspections, harvests, planting, tillage and irrigation and harvests *(Table 3)*.

A 90+ day forecast would potentially be used for selecting crops (seven respondents), purchasing crop insurance (nine respondents), determining forward contracting (nine respondents), determining seed rates (6/31) and choosing seed varieties (7/31). Three respondents mentioned potential benefit from a weather forecast for pasture grazing and outdoor building maintenance, determining 'irrigation amounts and ET rates', 'building structures laying concrete, yard and soil and water conservation work'.

Table 3: Which time horizon of forecasts do you use for the following decision? Please select all that apply.

#	Question	2-day	7-day	14-day	30-day	60-day	90-day	90 + day	Do not use a forecast	Responses
1	Selecting crops	0	1	0	1	2	2	7	19	32
2	Scheduling pesticide applications	18	15	3	0	0	0	0	0	36
3	Scheduling nutrient applications	6	18	4	4	0	0	0	3	35
4	Scheduling machinery maintenance	4	5	2	3	0	1	2	15	32
5	Conducting crop inspections	10	10	2	1	0	0	0	10	33
6	Purchasing crop insurance	1	1	1	1	1	3	9	16	33
7	Scheduling harvest	8	18	5	2	0	0	0	4	37
8	Scheduling planting	11	16	4	2	0	0	1	2	36
9	Scheduling tillage	6	13	2	2	0	0	0	10	33
10	Scheduling irrigation	2	9	0	0	0	0	0	22	33
11	Choosing seed varieties	0	1	0	2	1	3	7	18	32
12	Choosing seeding rates	1	2	1	2	1	1	6	18	32
13	Determining forward contracting	0	1	2	5	4	4	9	11	36

Are there other operations or decisions that are conducted that would benefit from a forecast?

Five out of 31 respondents indicated that there are other operations or decisions that are not listed in the survey that would benefit from a forecast. The comments are listed below:

- *"Pasture grazing and outdoor building maintenance"*

- *"Irrigation amounts and evapotranspiration rates"*

- *"Building structures, laying concrete, yard and soil/water conservation work"*

Potential and demand for mid-range forecasts.

Forecast information is needed by different respondents throughout the year but especially so in March, April and May. The emerging important attributes or usefulness for 90 day forecasts include: marketing, pre-selection of varieties and planting dates and the management decisions of planning and marketing.

Accuracy concerns and perceptions about 90-day forecasts: More than 80% of respondents are concerned about the accuracy of 90 day and more lead time forecasts *(Table 4)*. 25 out of 31 respondents were of the opinion that 90 day forecasts were never or rarely accurate.

Table 4: Level of accuracy of forecasts.

#	Question	Never Accurate	Rarely Accurate	Sometimes Accurate	Fairly Accurate	Very Accurate	Responses	Mean
1	2day	0	0	4	18	9	31	4.16
2	7 day	0	1	13	17	0	31	3.52
3	14 day	0	6	23	2	0	31	2.87
4	30 day	0	16	15	0	0	31	2.48
5	60 day	1	22	8	0	0	31	2.23
6	90 day	4	21	6	0	0	31	2.06
7	90+ day	6	20	5	0	0	31	1.97

Most respondents (68%), would not alter their practices on what to produce, how to produce it or how much, even if forecasters predicted a drought for the upcoming growing season with a 90-day lead time. Some of their responses included:

- *"90 day forecasts are rarely that accurate"*

- *"I do not believe it is possible to be accurate that far out"*

- *"Forecasts in general are not accurate enough"*

- *"It's a forecast, it is not set in stone, there are too many variables to accurately forecast that far in advance"*

- *"Not good information"*

However, when asked the same question with an additional element of forecast accuracy (75-100 percent statistical confidence), 81% of respondents demonstrated that their farm decision choices would change.

Respondents were asked when they would need a 90-day forecast of high accuracy (75-100 percent statistical confidence). Most of the respondents out of 31 preferred forecast information in March, April and May *(Table 5). (Please Note: Again, this question allowed for multiple answers).*

Table 5: During which months would you prefer to receive a 90-day climate forecast? Please select all that apply.

#	Answer		Response	%
1	January		7	23%
2	February		12	39%
3	March		20	65%
4	April		19	61%
5	May		17	55%
6	June		9	29%
7	July		10	32%
8	August		11	35%
9	September		7	23%
10	October		7	23%
11	November		5	16%
12	December		5	16%

25 out of 31 respondents, require forecasts that have a high level of accuracy (80% and above) in a 90-day forecast for it to be useful in making farm management decisions.

#	Answer		Response	%
1	10%		0	0%
2	20%		0	0%
3	30%		0	0%
4	40%		0	0%
5	50%		0	0%
6	60%		0	0%
7	70%		6	19%
8	80%		21	68%
9	90%		3	10%
10	100%		1	3%
	Total		31	100%

__Sample of Comments Related to Forecasts with Increased Statistical Accuracy__: "I might possibly switch to more soybeans if I was convinced that the forecast was accurate", "Might look at more drought tolerant crops, I mainly plant corn so I would be more likely to select hybrids that are fuller season and drought resistant", "I would rely on that to make some decisions", "The yes is qualified because I would want to see historical data showing that forecasts can consistently be made with 75 to 100 % accuracy", "The answer is really "maybe." Some forecaster is usually forecasting a drought in any given year. I have adjusted my decisions in the past and have been proven wrong."

Conclusions

From the survey some of the following key points emerged:

1. The internet, radio and TV are useful media for broadcasting forecasts.
2. Farmers value forecasts and there is a significant demand for **more accurate** forecasts.
3. Based on the development of more accurate forecasts, farmers may decide to make changes in their decision making, especially if the statistical confidence in the forecast is increased to at least 75-80%.
4. It may take considerable effort in demonstrating to farmers that the forecasts that could be produced could benefit their overall needs. (see overall comments to forecasts)